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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/310,156	12/02/2011	Shuja Hussain Andrabi	116418-328UT1	5091

123305 7590 01/31/2017
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EXAMINER	
KINKEAD, ARNOLD M	

ART UNIT	PAPER NUMBER
2842	

NOTIFICATION DATE	DELIVERY MODE
01/31/2017	ELECTRONIC

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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte SHUJA HUSSAIN ANDRABI and HASHEM ZARE-HOSEINI

Appeal 2016-000524
Application 13/310,156
Technology Center 2800

Before ADRIENE LEPIANE HANLON, LINDA M. GAUDETTE, and DEBRA L. DENNETT, *Administrative Patent Judges*.

GAUDETTE, *Administrative Patent Judge*.

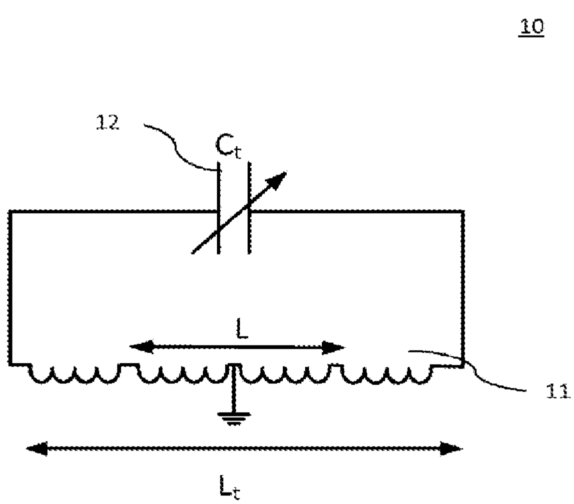
DECISION ON APPEAL

Appellants[1] appeal under 35 U.S.C. § 134(a) from the Examiner's decision[2] finally rejecting claims 1 and 3–16 under 35 U.S.C. § 103(a) as unpatentable over Tanabe (US 8,305,151 B2, iss. Nov. 6, 2012). We have jurisdiction under 35 U.S.C. § 6(b).

We REVERSE.

The invention relates to a technique for improving oscillator gain linearity. Specification filed Dec. 2, 2011 ("Spec."), 7:1–3. According to the Specification, nonlinearity in oscillator gain can directly affect the modulation accuracy of transmitters (used in radio communication and measurement devices) and corrupt the spectrum of the transmit signal. *Id.* at 1:5–21.

Figure 1, below, depicts a prior art oscillator LC tank (*id.* at 3:4):



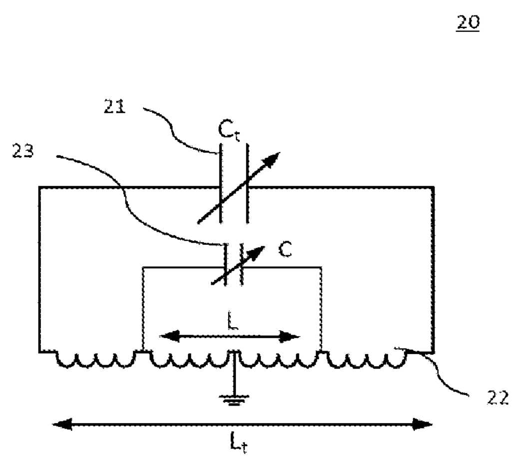
As shown in Figure 1, conventional LC tank 10 includes variable capacitor 12 coupled across inductance unit 11. Spec. 3:19–21. LC tank 10 together with an active circuit builds a conventional voltage controlled oscillator (VCO) core. *Id.* at

[1] Appellants identify the real party in interest as Cambridge Silicon Radio Limited. Appeal Brief filed Apr. 13, 2015 ("App. Br."), 1.
[2] Final Office Action mailed Nov. 20, 2014.

3:21–22. As shown in equation (1), below, gain of the oscillator (K_v) is dependent on the cubic of oscillation frequency (ω_0). *Id.* at 3:24–28.

$$\omega_0 = \frac{1}{\sqrt{LC_t}} \Rightarrow K_v \triangleq \frac{d\omega_0}{dC}$$
$$= -\frac{L}{2}\omega_0^3$$

Figure 3, below, depicts an oscillator LC tank in accordance with the invention (Spec. 3:6):



As shown in Figure 3, capacitance in LC tank 20 is divided into two parts. Spec. 4:4–5. Capacitance C_t, connected across the whole of inductance source L_t, is provided by first variable capacitor 21. *Id.* at 4:5–7. Inductance source L_t, is provided by inductance unit 22, which can comprise one or more inductors. *Id.* at 4:7–8. Capacitance C, connected across part L of inductance source L_t, is provided by second variable capacitor 23. *Id.* at 4:9–11. Capacitance C may be smaller than the capacitance C_t. *Id.* at 4:11–12. LC tank 20 together with an active circuit can be used to build oscillator core 24 (shown in Figure 4).

Oscillator gain (K_v) of the inventive LC tank is calculated in accordance with equation (5), below. *Id.* at 5:15, 24.

$$\begin{aligned} K_v &= \frac{d\omega_0}{dC} \\ &= -\frac{C_t}{2}\omega_0^3\frac{L\omega_0^2}{(1-\omega_0^2LC)^2} \\ &= -\frac{C_t}{2}\frac{L\omega_0^5}{(1-\omega_0^2LC)^2} \end{aligned}$$

As noted above, in the conventional LC tank, K_v is not constant, but is reduced by ω_0^3 when capacitance C increases. Spec. 5:20–22. "This means that the gain [(K_v)] varies over the tuning frequency range and the more the tuning range, the more gain variation." *Id.* at 3:29–20. In the inventive LC tank, however, K_v can be maintained at an almost constant value by changing the ratio of L/L_t, i.e., "a proportion of L_t can be selected or provided for L so as to substantially minimise the oscillator gain variation (or the nonlinearity of the gain) . . . across an operating frequency range." *Id.* at 6:15–19.

Claim 1 is representative of the invention, and is reproduced below:

1. A variable frequency oscillator comprising:

an inductance unit having a first inductance;

a first variable capacitor coupled across the inductance unit; and

a second variable capacitor coupled across a part of the inductance unit, the inductance of said part being a proportion of the first inductance;

the oscillator having an operating frequency range and the proportion being such as to substantially minimise the variation of rate of change of an operating frequency of the oscillator with a variation of a capacitance of at least one of the first variable capacitor and the second variable capacitor.

App. Br. (Claims Appx.) 8.

Tanabe Figure 1 is reproduced below:

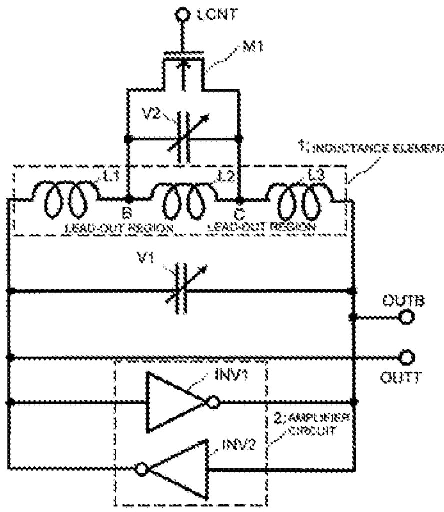


Figure 1 depicts an oscillator circuit (Tanabe 3:29) including inductance element 1 comprising series-coupled inductors L1+L2+L3, amplifier circuit 2, first capacitance element V1 coupled across inductance unit 1, and second capacitance element V2 connected across inductor L2 (i.e., a proportion of inductance element 1. Tanabe 4:1–17; *see* Final Act. 5.

The Examiner finds:

> [t]he reference to Tanabe *does not explicitly* suggest *minimizing the gain variation with a variation of a capacitance of at least one of the first variable capacitor and the second variable capacitor* and ***thus maximizing the linearity*** of the gain of the oscillator. However, the examiner notes that to keep the gain variation to a minimum over a wideband operation, for example, due to the inverse relationship shown in [Tanabe] equation 2 (see col 1) and the fact that the *gain (or gain variance) of the oscillator is dependent on the change in frequency of the oscillator, with respect to change in capacitance of first and/or second variable caps and inductors as well; the reference to Tanabe et al does allow for this.*

Final Act. 5. The Examiner contends:

> it would have been obvious to one of ordinary skill in the art to have recognized that the reference to Tanabe allows for the specific tuning of the L and C values to provide for the desired response characteristics overall as noted to reduce (minimize) the gain variation and derivative thereof to minimize noise at the desired range of operation.

Final Act. 6.

Appellants argue that the claims are directed to minimizing oscillator gain (K_v), defined in the Specification as "rate of change of an operating frequency of the oscillator with a variation of capacitance" (claim 1), and having the units Hertz per farad (Hz/F). Reply Brief filed Oct. 8, 2015 ("Reply Br."), 2 (citing Spec. 3:24–28); *see* App. Br. 5. Appellants contend Tanabe uses the term "gain" in referring to amplifier gain, which is the ratio of input to output signal, and is unitless. Reply Br. 2–3 (citing Tanabe, col. 1, Equation (2)); *see* App. Br. 5. Appellants thus contend the Examiner's finding that one of ordinary skill in the art would have understood from Tanabe Equation (2) that amplifier gain (ratio of input to output signal) variation could be minimized by adjusting L and C values, does not support a further finding that Tanabe suggests minimizing oscillator gain (rate of change of an operating frequency of the oscillator with a variation of a capacitance) in the manner recited in claim 1. *See* App. Br. 4–6, *e.g.*, *id.* at 5 ("As claimed, it is the choice of proportion of the first inductance across which the capacitor is coupled that provides this advantage.").

The Examiner, in response, maintains the similarity of Appellants' and Tanabe's circuits supports a finding that one of ordinary skill in the art would have had the ability to choose the appropriate proportion of inductance in Tanabe's oscillator so as to minimize variation of rate of change of an operating frequency of the oscillator with a variation of a capacitance as recited in claim 1. Ans. 3–4.

We have considered the respective positions of Appellants and the Examiner, and agree with Appellants that the facts and reasons relied on by the Examiner are insufficient to support a finding that Tanabe discloses or suggests an oscillator wherein "the proportion [relative circuit inductances] [is] such as to substantially minimise the variation of rate of change of an operating frequency of the oscillator with a variation of a capacitance of at least one of the first variable capacitor and the second variable capacitor," as recited in the last paragraph of claim 1. As argued by Appellants, the Examiner's finding that one of ordinary skill in the art *could have* adjusted L and C values in Tanabe to achieve the invention as claimed, is insufficient to support a finding that one of ordinary skill in the art would have had a reason to modify Tanabe's oscillator to have an operating frequency range and coupling of the capacitors across the inductance unit in the manner recited in the claims.

Accordingly, the Examiner's decision to reject claims 1 and 3–16 is:

<u>REVERSED</u>